

# ***IDA***

INSTITUTE FOR DEFENSE ANALYSES

## **An Introduction to IDA's S.E.N.S.E.<sup>TM</sup> – R.S.A. Project**

### **S.E.N.S.E. Project Team:**

**Dr. Richard H. White, Director, S.E.N.S.E. Project**  
**Mr. Edward Smith, Director, IDA Outreach Seminar Program**  
**Dr. An-Jen Tai, Deputy Director, S.E.N.S.E. Project**

**Mr. William E. Cralley**

**Mr. Joel Christenson**

**Professor David Davis**

**BG William Fedorochko, Jr., USA (Ret.)**

**Dr. Jack LeCuyer**

**Mr. Dayton Maxwell**

**Mr. Klaus Niemeyer**

**Mr. Edwin Pechous**

**Ms. Danielle Philips**

**Mr. Ian Rehmert**

**Mr. Marc Samuels**

**Ms. Katherine Ward**

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## PREFACE

This document was prepared as part of the IDA task, Synthetic Environments for National Security Estimates – Regional Security Application (S.E.N.S.E.-RSA). It is intended as a short introduction to the research under way at IDA to investigate the application of the S.E.N.S.E. methodology to so-called complex contingencies as defined by Presidential Decision Directive 56 (PPD-56). It also explores extensions of the R.S.A. work to potentially address multiple crises on a local and global scale under the moniker *Checkmate!*

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## **An Introduction to IDA's S.E.N.S.E.<sup>TM</sup>-R.S.A. Project<sup>1</sup>**

Synthetic Environments for National Security Estimates, or S.E.N.S.E., is a virtual environment that may be used to provide policy makers with strategic insights and foster "out of the box" thinking. It offers a systematic framework for crisis identification, avoidance, rehearsal, management, and remediation by offering a "parallel economic/political/military/social dimension" in which analysts and decision makers can take part in virtual exercises to identify potential crises, scope options, and test crisis action plans. S.E.N.S.E. affords the opportunity to move beyond collaborative discourse and information exchange into a milieu that allows users to develop constructs that may be collectively *experienced*.

The principles guiding both the technology used to support S.E.N.S.E. and the types of human interactions encouraged through scenario play derive from extensive work done by the U.S. Department of Defense in the area of virtual combat modelling. Like many of these models, S.E.N.S.E. is a distributed, interactive simulation facilitated by a network of computers. While computers are used, courses of action are chosen by participants – decisions are all "human-in-the-loop."

### **A. Background and History**

S.E.N.S.E. began in 1996 as an IDA centrally-funded research project. Originally it was intended as a proof-of-concept to demonstrate how to address major national security issues beyond the military domain, with a focus on economic security. The original focus was to address the questions: how can we better understand economic globalization and its impact on traditional notions of security for nation states? And, what are the interrelationships among prosperity, security, and stability in a multipolar world where asymmetric threats and non-traditional security issues must be considered?

Since that time, S.E.N.S.E. has evolved into a generalizable architecture for desktop distributed, interactive simulation capable of simultaneously addressing not only economic but also social, political and military issues. It is a modeling and simulation architecture and methodology that may be used for training, analysis, cross

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<sup>1</sup> S.E.N.S.E. stands for Synthetic Environments for National Security Estimates and is an IDA trademark.

cultural/disciplinary communication, and to provide insights for senior decision makers. Two types of environments have been developed to date. The first generation addressed information warfare issues stemming from experience with the President's Commission on Critical Infrastructure Protection (PCCIP). The second generation was motivated by a desire on the part of U.S. leadership to address the non-military stability dimensions of post conflict environments and focused initially on the Bosnia-Herzegovina situation. It extended the scope of the earlier effort by combining seminars, simulation, and after action reviews to execute and interpret the results from "unscripted" scenarios.<sup>2</sup>

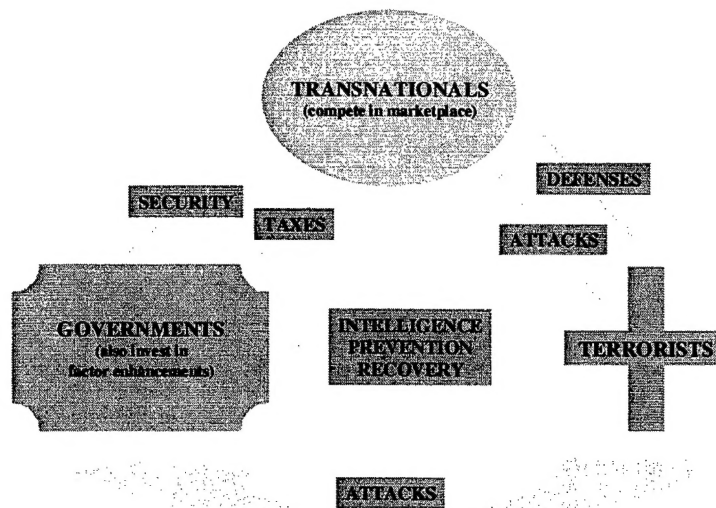
Most recently, IDA was funded by the Department of Defense to pursue the application of the S.E.N.S.E. methodology to so-called "complex contingencies." This effort has led to work on how to apply the principles of distributed desktop simulation to periods of instability leading up to conflicts, and how to remediate and rehearse for contingencies. The effort to specifically address complex contingencies has been given the moniker S.E.N.S.E.-R.S.A. for Regional Security Application. A more general derivative suggested by IDA research dealing with concurrent multiple contingencies of differing natures has been named "*Checkmate!*"

## **B. First Generation S.E.N.S.E. - Information Warfare**

In collaboration with Purdue University, an information warfare and transnational corporation game was developed during the summer of 1996 and deployed in conjunction with an IDA-sponsored Symposium on Synthetic Economies. The purpose of this "game" was to test the hypothesis that a computer architecture could support interactive role-playing among a host of participants, each pursuing a set of heterogeneous goals. As shown in Figure 1, this version of S.E.N.S.E. was a simple depiction of a transnational reality where firms pursued profits, governments focused on economic development and security, and terrorists sought to disrupt information infrastructures and undertake blackmail.

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<sup>2</sup> By an "unscripted" scenario we mean that while initial conditions are posited, and independent events may be introduced during play, the unfolding of actions, strategies, and responses is purely a function of the human participants in the synthetic environment.

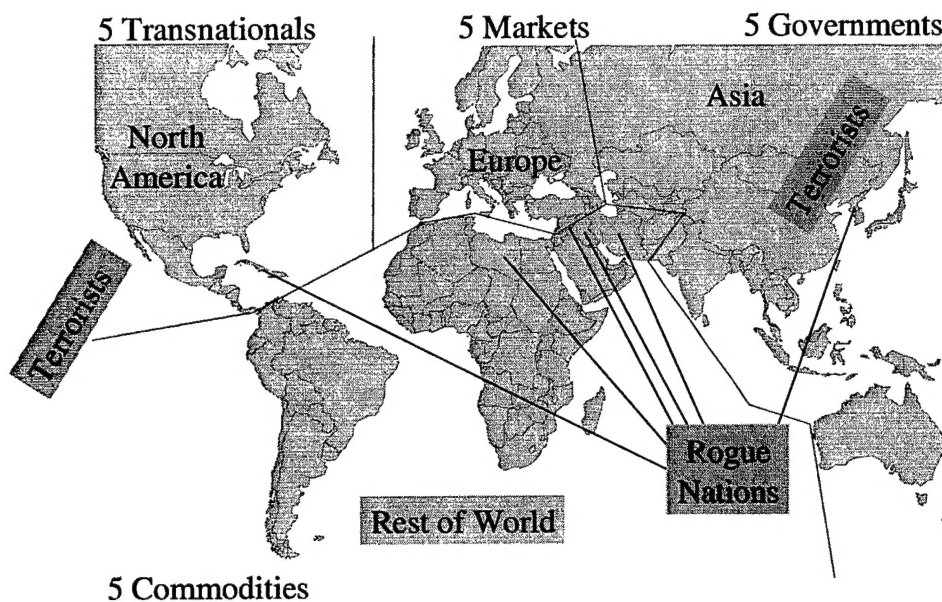


**Figure 1: Interactions Among Participant Types**

The setting for the first generation information warfare game was a simplified global economy divided into five regions, five governments, five transnational corporations, and a single terrorist cell (Figure 2). Households were used to clear markets according to different regional utility functions. This led to a differentiation in profit rates among regions and markets, and a rationale for transnationals to make home country and foreign investments, as well as to trade across borders. In this setting, Governments sought to protect transnationals within their borders from terrorist-initiated information warfare attacks by raising general security levels (law enforcement), while the firms individually decided whether or not to purchase additional security.

In order to simulate the affects from an information warfare attack, a time and monetary penalty were exacted from victims. Depending upon the severity of a successful attack, which was a function of the difference between a defenders security level and an attackers weapon, the victim's keyboard was frozen for a specified period of time and their cash balance reduced by a calculated amount. The exact security level and the level of threat, however, were unknown to defender and attacker, respectively, prior to an attack. In addition, terrorists were allowed to send ransom notes to potential victims in an attempt to extort monies without resorting to their arsenal. As a result, at their peril, defenders had the option to ignore a ransom request or comply and trust the terrorists (who could still attack).

A variant of the game was also tried, where all participants could perpetrate terrorist attacks. This demonstrated the flexibility of the gaming paradigm and tested the impact of multiple attacks occurring simultaneously among numerous players.



**Figure 2: Regions, Commodities, and Players**

In general, lessons learned from the information warfare gaming sessions included:

1. the need for firms to raise their security levels quickly prior to the initiation of terrorist attacks;
2. the inability of government to affordably provide more than a basic level of information security; and
3. the sensitivity of firms to both rates of return and security, on a region by region basis.

### **C. Second Generation S.E.N.S.E. - AKRONA**

The second generation S.E.N.S.E. simulation, also known as AKRONA, was developed in response to a desire to “*teach economics 101 without lecturing economics 101.*” Twice peer-reviewed by well-known academics, AKRONA has been used internationally in The Hague with Montenegrins. The point of the Hague exercise was to immerse the Montenegrin participants in a simulated democratic free-market society and thus expose them to the inner workings of the capitalist economic system. As General Clark pointed out in his interview with *Defense News* following the simulation: “What we’ve learned is that you can’t achieve stability if you can’t achieve prosperity.”



While AKRONA is fictitious, the problems and issues brought into the gaming session by the Montenegrin and other participants are real. Because AKRONA is endowed with economic, social, and demographic characteristics closely aligned to the environment from which the participants are drawn, individual and group actions are conditioned by their experiences. Unconstrained by extant bureaucratic structures and organizational biases, the participants are afforded the opportunity to create new workable structures and conventions to deal with the economic and social issues posed by the simulation.

The AKRONA simulation provides a realistic economic experience. Both a private sector and a public sector are modelled; the current version of the game supports 24 economic sectors. All sectors are connected to the international economy. Government has control over taxes and tariffs, and can influence investments by the private sector on a sector-by-sector basis. While player economic interactions are tracked and facilitated via the computer network provided by the S.E.N.S.E. architecture, personal interactions are encouraged as part of the course of play.

The AKRONA simulation at The Hague included six major player types organized according to economic roles in 12 participant cells. Each cell contained two personal computers, a tutor-coach, a translator, and three or more Montenegrin participants. In addition to the Montenegrin players, professionals from western governments and the private sector participated to represent the interests of international organizations, foreign investors, non-governmental organizations, and foreign governments. NATO Consultation Command and Control Agency (NC3A) staff served as tutor-coaches and provided real-time training for Montenegrin participants; the remaining non-Montenegrin participants used the simulation as a vehicle to provide real-world lessons by making foreign investments, providing external sources of capital, and entering into joint ventures with domestic firms. (Table 1)

As shown by the schedule in Table 2, the AKRONA application of S.E.N.S.E. is much more than a simulation. It employs seminars to provide participants with context and background for scenario orientation and development. It uses distributed interactive simulation to allow participants to test their hypotheses, policies, and strategies. And, it employs after-action reviews to elicit participant views, provide player-to-player discourse, reinforce principles, and assist with mutual understanding across ethnic and cultural boundaries.

**Table 1: Roles and Representative Player Types**

| Cell Type                     | Number | Role   | Participants  |
|-------------------------------|--------|--|---|
| Firm                          | 6      | To represent the interests of private sector firms   | 19 Montenegrins                                       |
| Bank                          | 1      | To provide commercial capital at market rates  | 4 Montenegrins  |
| Transnational Corporation     | 1      | To represent the interests of foreign investors and lenders  | 2 Western Investors                                   |
| Foreign Government            | 1      | To provide both economic and military aid, as well as direct military support  | 2 Foreign Government Officials                        |
| Non-Governmental Organization | 1      | To represent the interests of non-governmental organizations in general  | 2 Representatives from non-governmental organizations |
| International Organization    | 1      | To represent the interests of the World Bank and IMF   | 2 Foreign government officials                        |
| Domestic Government           | 2      | To govern AKRONA through use of a civilian budget, a military budget and the ability to undertake financial operations such as lending and borrowing | 18 Montenegrins                                       |

Lessons that participants are expected to derive from an AKRONA gaming session include:

- How a market economy functions;
- The role of entrepreneurs, risk-taking, and capital investments;
- The need for a strong legal foundation as the basis for enforcing contracts;
- The critical importance of dialogue among the myriad players in the private and public sectors, as well as the need for transparency to promote confidence, credibility, and consensus;
- The role of macroeconomic decisions in affecting economic opportunities;
- The need to balance domestic needs with foreign demands;
- The interplay of defense funding and the national economy;
- How to achieve long-term national prosperity and rising social welfare.

The Montenegrin participants displayed a very active and enthusiastic role in the workshops and the simulation. The natural way of learning by doing, and seeing the consequences of decisions, created an intense positive feeling amongst the participants of having jointly solved a fundamental national problem. The players quickly learned that cooperation, communication, interaction, bargaining, and negotiation are essential ingredients for successful behavior in evolving societies. The non-committal atmosphere and the very active audience led to open and frank discussions and exchanges of views.

The impact of experts from Western industry and banks was of great value and has to be seen as essential.

**Table 2: Simulation and Seminar Schedule**

| <b>Stage-Setting</b>             | <b>Recovery</b>       | <b>Reconstruction</b>       | <b>Development</b>       | <b>Reflection</b>    |
|----------------------------------|-----------------------|-----------------------------|--------------------------|----------------------|
| Future worlds                    | Economies of Recovery | Economics of reconstruction | Economics of development | Stability CCC, Cm/Cr |
| Spectrum of Power                | Strategy (Trade-Offs) | Strategy (Trade-Offs)       | Strategy (Trade-Offs)    | Reflection/Insights  |
| External/Internal Expectations   | Simulation            | Simulation                  | Simulation               | After Action Review  |
| National Objectives & Priorities | Simulation            | Simulation                  | Simulation               |                      |
| Introduction to Simulation       | After Action Review   | After Action Review         | After Action Review      |                      |
| <b>Day 1</b>                     | <b>Day 2</b>          | <b>Day 3</b>                | <b>Day 4</b>             | <b>Day 5</b>         |

The response from sophisticated simulation participants, former senior government officials, and well-known academics has been that AKRONA accomplishes the intended task – engaging participants in an environment that helps convey an understanding of complex interdisciplinary issues. Some comments from participants in the exercise are:

**Sandra Berberovic, Office of the Deputy Prime Minister for Social Issues:**

“This is an interesting game and I really enjoyed seeing my government work as a team, which is not an opportunity when you work in one Ministry – you do your job and you don’t get a chance to see how the whole system functions.”

**Mila Kasalica, Bank for Development of Montenegro:** “I will try to explain to my colleagues and my collaborators that responsibility is the key to everything. It’s not just a phrase – it’s really a good thing when you cooperate and you are responsible for your actions.”

**Jerome Visser, Manager, Ministry of Defence, The Netherlands:** “Well, the most important thing about this simulation is that – unlike other simulations, its very interactive and normally in a simulation you would only see the results after a day and here after 15 minutes you already see what is happening and they have to really anticipate on what is going on in the world and so the learning curve is incredibly steep – and that’s very good.”

**Stephen Moses, Stephen Moses Interests:** “It was very realistic. The people got into their roles and really reacted the way they would react in real life. Many of the decisions we saw them making were very much the kind of thing that we have run into as we’ve been trying to do business in this part of the world.”

**Dr. Colin Bradford, Department of Economics, American University:** “I guess the thing that most impresses me frankly is that there’s almost a degree of

solemnity involved in the way that these people are playing this game. I think they've realized that this AKRONA economy in the end is not just AKRONA but in the back of their minds they are aware that it is a realistic economy and a realistic simulation of what they face at home. So, the thing that most impresses me is the seriousness with which they seem to playing the game and taking the outcome as lessons that they can apply when they return home."

#### **D. R.S.A. and *Checkmate!***

In a broader security context, S.E.N.S.E.'s economic, social, political, and military modeling and simulation can be employed to provide policy makers with important insights about the implications of their proposed courses of action. Analysts and senior officials could be immersed in synthetic environments prior to and, to the extent that time permitted, during crises, to more effectively characterize available options. The resulting interactions among simulation participants, particularly the possible non-linearly-related  $n^{\text{th}}$  order implications of their individual decisions, could be addressed with real-time analytical tools – instantaneous policy feed-back for analysis and evaluation. These are the ideas behind R.S.A. and *Checkmate!*

##### **1. Evolving S.E.N.S.E.: R.S.A. and *Checkmate!***

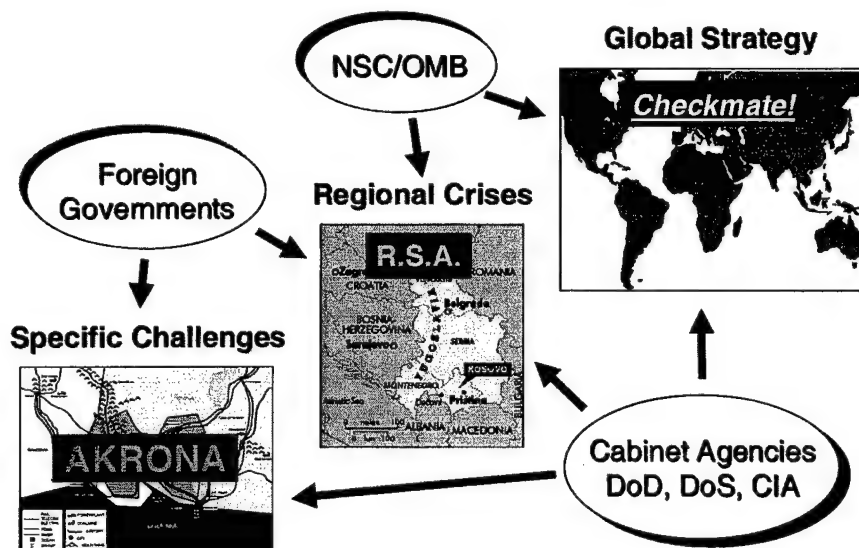
The philosophy behind S.E.N.S.E. is to leverage existing commercial and government information system technologies and modeling capabilities. The technical challenge is to assemble a seamless simulation environment from heterogeneous parts. The result must be an environment capable of supporting both experimentation and exercises concurrently. Architectural considerations are of paramount importance to preserve future flexibility while providing ongoing operational capabilities.

The Information Warfare and AKRONA versions of S.E.N.S.E. demonstrate that the necessary technical architecture need not be complex. However, the interrelationships among constituent parts are exceedingly complex from a domain-specific perspective (political, economic, social, military, etc.). The goal is to achieve a modular simulation construct that allows users to choose the types of supporting analytical capabilities for their task, and then to be able to configure these capabilities from an assortment of government and commercially-available software packages, along with custom-written code.

To make sure that the synthetic environment is useful to target communities, there is a need to inculcate double-loop-learning processes (build-exercise-build) throughout the development process. In particular, those areas that are effectively handled through

models and simulations, and those areas that are best handled through more traditional seminar "wargame" techniques must be identified. To get the most from the simulation, gaming, rehearsal, planning, and analysis during execution must be viewed as a combined "curriculum," leveraging the strengths of different components.

There are many different levels that could be represented within the S.E.N.S.E. framework. Figure 3 illustrates three different tiers currently envisioned. The first two generations of S.E.N.S.E., the Information Warfare and AKRONA games, are examples of specific challenges addressed through a simplified, non-geospatial, single site implementation of the S.E.N.S.E. methodology and architecture. R.S.A. would add the geospatial and multi-site dimension in order to address a broader range of issues and simultaneously reach a larger audience. And, *Checkmate!* would be designed to allow multiple regional crises to be addressed simultaneously.



**Figure 3: Three Levels of S.E.N.S.E. Simulation**

Whereas the AKRONA game is fundamentally an economic one, R.S.A. and *Checkmate!* would be national security simulations where the economic component is used to address humanitarian issues and provide a means for simulating the impacts of embargoes, bombing campaigns, and overall social stability. This raises an important issue: How much new development must be undertaken to create each of these tiers? The short answer is that the amount of additional development required will be a function of what is readily available and our ability to apply the architecture to make use of these capabilities.

In the economic arena there may little need to develop new modeling and simulation. Rather, a large number of constructs already exist and have been validated. On the other hand, there is a need to develop the ability to support individual simulations, while also integrating their functioning and results. AKRONA is a proof of principle that this can be done for a single model, and that this model can be used simultaneously by many participants as the heart of a distributed simulation. However, as S.E.N.S.E. is intended to be *experiential* and not predictive, significant efforts will need to be applied to validating the application of economic principles for simulation purposes.

There are an enormous number of opportunities for incorporating non-economic simulations as part of S.E.N.S.E. For instance, for military engagements, JCATS, JWARS, and other combat models could be used, the results of which would be fed back into the economic and socio-political aspects of the simulation. Budgeting and cost models, such as the Defense Resource Management Module (DRMM) and the Contingency Operations Support Tool (COST), are available but may need to be rewritten in order to be integrated into the S.E.N.S.E. architecture. As well, there are many command and control tools, such as Adaptive Course of Action (ACOA) and the Global Command and Control System (GCCS) that might find use in more advanced and ambitious applications of the S.E.N.S.E. paradigm.

## **2. S.E.N.S.E. as a Crisis Assessment and Rehearsal Capability**

Both R.S.A. and *Checkmate!* would be designed to be used either as gaming or assessment environments. In the gaming role, they would serve as a means to help identify and rehearse the inter- and intra institutional arrangements necessary to swiftly and decisively address crises as they unfold in order to contain them and minimize their impacts. As an assessment tool, these environments could be fed real-time intelligence and other information in order to create a "parallel" virtual reality useful for doing "what if?" assessments and for engaging in quick response games as part of course of action analysis.

### **a. Prior to Crises**

Before a crisis begins to unfold, R.S.A. and *Checkmate!* could be used to help analysts and decision makers understand what to look for, what the key decision factors affecting outcomes might be, and how alternative futures might "shake out."

- **What should I look for, and what does it mean?** The timely availability of enormous amounts of data from a wide variety of sources is a reality. How to effectively use these data to make informed decisions – how to array data so that

they become information – is much less clear. Particularly difficult is the task of taking data from different “knowledge domains” (different communities such as defense, economics, science, business, psychology, etc.) and using them for effective crisis management. Understanding what the data mean and what an analyst looks at largely depends upon an individual's background and experience.

S.E.N.S.E. would become part of the day-to-day routine for analysts and decision makers – it would not be a crisis-only tool. Rather, it would be the virtual environment in which ongoing assessments are tested. It would leverage collective expertise by engaging here-to-fore separate and disparate activities in the pursuit of common objectives. The crisis management community as a whole would improve its ability to know what to look for – what data are already available, what data to collect, and what data are missing.

- **How can intelligence collection requirements be more effectively developed and refined?** Because of the deluge of data from sensors and sources, there is an ever growing need to be able to focus on what is essential and what is of minor importance or irrelevant. S.E.N.S.E. would aid analysts in the job of separating wheat from chaff. In addition, it would offer new analysts ways to understand the strategic relevance of their work and help them think about long-term consequences. In this way, S.E.N.S.E. is also a training and educational tool.
- **What are possible alternative futures?** S.E.N.S.E. would serve as a means for conveying complex situations to the nation's senior leadership. In concert with other information tools, it would allow decision makers to experience for themselves the potential or alternative outcomes of analytical assumptions, knowns, inferences, and recommended courses of action. As such, it would be a prime means of conveying the implications from one or another recommended courses of action, as well as of allowing consideration of a series of moves, counter moves, and counter-counter moves.
- **What is the desirability of different outcomes?** S.E.N.S.E. would provide a framework for collaboration and decision making among diverse actors in the national security community. The corollary to this approach is the operations planning process used by the Joint Staff to prepare for possible military contingencies. However, rather than a paper exercise, S.E.N.S.E. would provide a virtual decision-making framework for the collaborative *experience* of courses of action. S.E.N.S.E. would be an umbrella process for the combined political/economic/security environment that characterizes the post-Cold War era. Within this framework, it would allow analysts to see how different local threads affect the global fabric.

#### **b. During Crises**

By their very nature, crises imply extremely short decision horizons, so leisurely analysis is out of the question. What is needed is a way to rapidly construct and test



hypotheses based upon "knowns" and "inferences." Since it is not possible to play out multiple courses of action in the real world, a synthetic environment is required. This synthetic environment must be capable of providing insights for choosing or modifying courses of action. It needs to be capable of combining live, virtual, and constructive actors. And, it must facilitate speculative "thought experiments," incorporating "human-in-the-loop" inputs from decision makers.

- **How fast is fast enough?** Timing is everything. Because crises are multi-dimensional and therefore very complex, a way is needed to test hypotheses on the fly. S.E.N.S.E. would allow decision makers to work through the consequences of events quickly, in compressed real time. Many different courses of action might be tested to identify low-risk, high-leverage strategies. Off-the-shelf, generic courses of action developed prior to a crisis might be employed during a crisis as initial conditions or first approximations – providing an instant orientation for analysts and decision makers who participate in pre-crisis exercises.
- **Who are my counterparts, and how will they react?** Teamwork is also critical to successfully bringing a crisis to closure. S.E.N.S.E. fosters networks of human contacts across agencies and improves interagency working relationships. Because this would be done on a collaborative basis, the cross-institutional linkages necessary to address crises are put in place well before they arise. In addition, through scenario play and rehearsal, institutional and individual positions can be mapped-out before hand, and a common "language" for discussing the particularities of a crisis can be worked out in advance.
- **What are the key decision factors affecting outcomes?** In any crisis, it is critical that information triage be performed as early as possible. Data and information must be quickly distilled to identify the decision factors that are most likely to influence outcomes. Even before a crisis arises, S.E.N.S.E. offers the possibility of rehearsing action plans and formulating scenarios to assist analysts in identifying threats and to improve the interpretation of intelligence and other data available to them. S.E.N.S.E. would also provide opportunities for staff experts and senior decision makers to interact prior to crises. As a result, these factors may be more readily identified, since many of the conditions of a crisis will have already been experienced.

## **E. Achieving the Synthetic Future, a Summary**

The philosophy behind S.E.N.S.E. is to leverage existing commercial and government information system technologies and modelling capabilities. The technical challenge is to assemble a seamless simulation environment from heterogeneous parts. The result must be an environment capable of concurrently supporting both



experimentation and exercises. Architectural considerations are of paramount importance to preserve future flexibility while providing ongoing operational capabilities.

The Information Warfare and AKRONA variants of S.E.N.S.E. demonstrate that the necessary technical architecture need not be complex. However, the political, economic, social, and military interrelationships that must be fostered lead to an extremely complex interplay of forces, factions, and agendas. Experience with the first two S.E.N.S.E. environments suggest that a desktop distributed interactive simulation for senior policy makers can produce results unattainable through more traditional seminar gaming venues.

In a broader security context, R.S.A. and *Checkmate!* could be employed to provide policy makers with important insights about the implications of their proposed courses of action. Analysts and senior officials could be immersed in synthetic environments prior to and, to the extent that time permits, during crises, to more effectively characterize available options. The resulting interactions among simulation participants, particularly the possible non-linearly-related  $n^{\text{th}}$  order implications of their individual decisions, could be addressed with real-time analytical tools – instantaneous policy feedback for analysis and evaluation.

To ensure that the synthetic environment is useful to target communities, there is a need to inculcate double-loop learning processes (build-exercise-build) throughout the development process. In particular, those areas that are effectively handled through models and simulations, and those areas that are best handled through more traditional seminar "wargame" techniques, must be identified. To get the most from the simulation, gaming, rehearsal, planning, and analysis during execution must be viewed as a combined "curriculum," leveraging the strengths of different components. There are many different levels that could be represented with the S.E.N.S.E. framework. One issue is how much new development must be undertaken to create each of these tiers. The answer to this is a function of what is readily available, and what is our ability to develop an architecture that will make use of existing capabilities.

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